UNIVERSITY OF CALIFORNIA

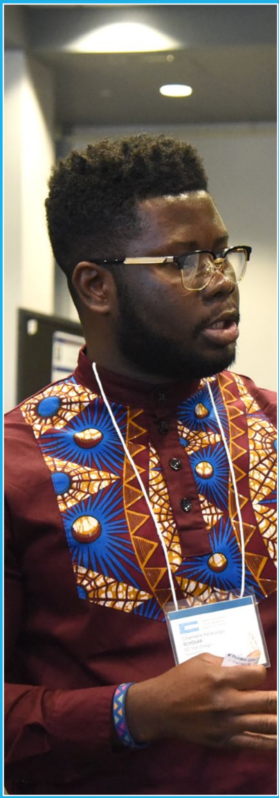
Leadership Excellence through Advanced Degrees (UC LEADS)

21st Koret UC LEADS Research and Leadership

SYMPOSIUM

March 6, 2021 | HOSTED ONLINE

PREPARING **PROMISING** **SCHOLARS**



Contents

AGENDA

2021 Koret UC LEADS Research and Leadership Symposium
March 6, 2021

TIME	EVENT
8:30 AM – 9:20 AM	Welcome & Keynotes
9:20 AM – 9:30 AM	Break
9:30 AM – 11:15 AM	Celebration of Research Presentations
11:15 AM – 11:30 AM	Break
11:30 AM – 12:30 PM	Alumni Panels
12:30 PM – 12:45 PM	Break
12:45 PM - 1:30 PM	Awards Ceremony

LOCATION

Zoom Link
Password: research

Preceeding Symposium Activities

Monday, March 1st	Presentation Competition
Tuesday, March 2nd	Presentation Competition
Wednesday, March 3rd	Presentation Competition

UC LEADS

WELCOME FROM ASSISTANT DEAN, DR. ROBERT HAMM

Dear UC LEADS scholars, faculty, staff, and guests:

It is my pleasure to welcome you to the 21st Annual Koret UC LEADS Research and Leadership Symposium. This year, the Symposium remains a celebration of science and scholarship, but it also celebrates the remarkable perseverance exhibited by our UC LEADS scholars over the last year. Your futures are bright, as evidenced by your ability to remain engaged, even while remote. I want to congratulate you on your research presentations and to acknowledge the hard work and dedication that produced these exciting discoveries.

It is also my pleasure to thank the incredible UC LEADS campus leadership teams, who not only made this event possible, but who also put in tremendous effort over the last year to re-envision their programming and student support. The UC LEADS Executive Steering Committee was also helpful in thinking through how to effectively adapt. Finally, I would like to thank the judges who gave their time and mentorship as part of this Symposium, as well as the mentors who reimaged their research last summer to engage these scholars remotely.

We look forward to seeing everyone in person again at UC San Diego in March 2022. Until then, please enjoy our virtual celebration today.

Sincerely,

Robert Hamm

Robert Hamm, PhD
Chair, UC LEADS Executive Steering Committee
Assistant Dean,UC Santa Barbara Graduate Division

UC LEADS COORDINATORS

BERKELEY
Diana Lizarraga, Director, Cal NERDS Program, Division of Equity and Inclusion
Chris Noble, Assistant Director, Cal NERDS Program, Division of Equity and Inclusion

DAVIS
Lynne Arcangel, Director, Graduate Preparatory Programs, Graduate Studies

IRVINE
Daniel Fabrega, Manager, Outreach, Recruitment and Retention, Graduate Division
Mariela Menendez, Outreach and Recruitment Coordinator, Graduate Division

LOS ANGELES
Fernando Gomez, Assistant Director, Undergraduate Research Center
Breana Musella, Program Coordinator, Undergraduate Research Center - Sciences

MERCED
Jorge Arroyo, Director, Undergraduate Research Opportunities Center
Emily Heng, STEM Program Coordinator, Undergraduate Research Opportunities Center

RIVERSIDE
Maria Franco-Gallardo, Program Director, Academic Preparation and Outreach

SAN DIEGO
Edgar Beas, Student Affairs Coordinator, Graduate Division

SAN FRANCISCO
Zachary Smith, Program Manager, Diversity and Outreach, Graduate Division

SANTA BARBARA
Walter Boggan, Director, Admissions, Outreach and Diversity Initiatives, Graduate Division
Briana Muñoz-Flores, Assistant Director, Outreach, Graduate Division

SANTA CRUZ
Yulianna Ortega, Director, STEM Diversity Office
Xingci Situ, Coordinator, STEM Diversity Office

UC LEADS STATEWIDE LEADERSHIP
Dr. Robert Hamm, Chair, UC LEADS Steering Committee
Michele Johnson, Statewide Director, UC LEADS

KEYNOTE SPEAKER

Dr. Andrew Ekelem
Chief Product Officer Evolution Devices

Andrew Ekelem, PhD is a Cal Golden Bear who gravitated towards the engineering disciplines early in life. Throughout his first two years at Cal, Andrew switched majors numerous times before falling into his passion for bioengineering. Unfortunately, the fall was quite literal as he severely injured his spinal cord during a snowboarding session. From that traumatic experience, Andrew was introduced to numerous real-world problems to focus his engineering efforts.

Through the UC LEADS program Andrew was able to participate in research on spinal cord injury therapeutics on rat and mouse models. The novel therapeutics included retroviruses, NSAIDs, and many more investigational therapies. After learning substantial neurobiology, he dove into rehabilitation robotics with leading mechanical engineering innovators. The second UC LEADS summer gave Andrew the opportunity to develop mechatronics alongside an exoskeleton team at UC Berkeley. That experience and a attending a research symposium on functional electrical stimulation as a spectator catalyzed the network that would take Andrew to Vanderbilt Center for Intelligent Mechatronics, where he completed his doctorate in mechanical engineering. Andrew's dissertation focused on controls of a hybrid exoskeletons that combine electric motors with functional electrical stimulation of the muscles. Through scientifics protocols Andrew showed hybrid controls can enhance both the therapeutic effect and efficiency of assisted walking for persons with paraplegia. After graduate school Andrew joined Evolution Devices as the Chief Product Officer to commercialize an artificial intelligent wearable muscle stimulator and markerless motion capture technology for rehabilitation of people after neurotrauma.

ALUMNI SPEAKERS

Dr. Amanda Armijo

Amanda Armijo received her B.S. in Microbiology, Immunology, and Molecular Genetics in 2008 and her Ph.D. in Molecular and Medical Pharmacology in 2014 from UCLA. Amanda received her D.V.M. from Cornell University in 2017 and is currently a veterinary postdoctoral fellow at MIT. Amanda's research interests include nucleotide metabolism and environmental toxicology. Her work and collaborations have led to multiple publications in several journals, including Cell Reports, Journal of Experimental Medicine, and Journal of Medicinal Chemistry. She plans to pursue a career in research and laboratory animal medicine.

Dr. Francisco Ponce

Francisco Ponce is currently a Post-Doctoral Scholar with the SuperCDMS and Quantum Information Science groups at Pacific Northwestern National Laboratory. His background is in low temperature high resolution superconducting x-ray/particle detectors. His current research is focused on searching for dark matter and understanding noise sources that degrade Qubit coherence times. Prior research includes studying 229m-Th for use in a nuclear clock at LLNL and use of cryogenic detectors at the ALS in LBNL. Francisco received a Bachelor's in Physics and Applied Mathematics at UC Berkeley, Master's in Physics at SFSU and Ph.D. in Physics at UC Davis.

Dr. Gregory Heller

Gregory Heller attended UC Riverside for his undergraduate education. It was at UCR that he first began doing research in the lab of David Reznick, studying microevolution in fish. This interest in research led joining the UC LEADS program the summer after sophomore year where he joined the lab of Dr. Li Fan, studying the three-dimensional structure of DNA repair proteins. His second summer in the program he went to UCSF and worked under Dr. Krystof Bankiewicz studying novel adeno-associated viruses (AAVs) for use in gene therapy. It was here that his interest in gene therapy was born. Upon graduating UCR, he went to the Mayo Clinic as part of their post-baccalaureate research education program (PREP). He joined the lab of Dr. Michael Barry to further his research interests in gene therapy - he studied how to use adenovirus for gene therapy and selectively killing cancer cells. He then joined the University of Illinois, Chicago Medical Scientist Training Program (MSTP) to attain his MD and PhD degrees. He is currently working in the lab of Dr. Ernesto Bongarzone examining the long-term efficacy of AAV mediated gene therapy in the mouse model of a fatal, demyelinating disorder - Krabbe Disease.

Dr. Jacqueline Kimmey

Bio: Dr. Jacqueline Kimmey is currently an Assistant Professor in the Department of Microbiology and Environmental Toxicology at the University of California Santa Cruz. Jacqueline started her research career as a UC LEADS scholar and subsequently as MARC scholar while an undergraduate at UCLA (graduated 2011). She earned her PhD in Molecular Microbiology and Microbial Pathogenesis from Washington University in St. Louis in 2016 and completed her postdoctoral training at UC San Diego. In 2019, she started her lab (www.kimmeylab.com) at UC Santa Cruz focusing on how differences in host immune responses impact susceptibility or resistance to *Streptococcus pnuemoniae* infection.

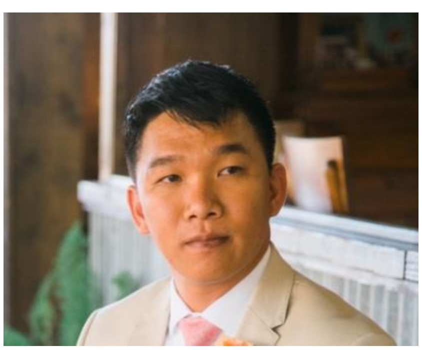
ALUMNI SPEAKERS

Dr. Jennifer Garcia

Jennifer Garcia is an Assistant Professor of Molecular Biology and a Boettcher Investigator at a small residential liberal arts college called Colorado College and a former UC LEADS scholar who studied Biochemistry/Chemistry at UC San Diego. At Colorado College, she teaches multiple courses and focuses her research with undergraduates to gain a holistic understanding of how both transcriptional and post-transcriptional processes coordinate to promote proper cellular function under conditions of stress using baker's yeast. Previously, she was NIH NRSA Postdoctoral Fellow at CU Boulder in Dr. Roy Parker's lab. Prior to CU Boulder, she completed her Ph.D. at UC San Francisco where she studied epigenetics to understand how molecular packaging of DNA into the cell can alter its expression. She was introduced to the UCSF graduate program while a UC LEADS scholar when she did a summer research project with Dr. Elizabeth Blackburn. The UC LEADS program also introduced her to the model organism that she uses today, baker's yeast, when she was an undergraduate in the lab of Dr. Tracy Johnson at UC San Diego.

Dr. Jeniffer Hernandez

Dr. Jeniffer Hernandez received her B. S. in Molecular, Cell, and Developmental Biology at the University of California, Los Angeles (1999-2003) and conducted research in the laboratory of Dr. Judith Lengyel. She then received her Ph.D. from University of California, Irvine and conducted research in the laboratory of Dr. Craig Walsh (2005-2011). During her PhD training, Dr. Hernandez discovered the mechanism of resistance of autoimmunity in a mouse model of multiple sclerosis that harbors a deletion of the kinase DRAK2. As a post-doctoral fellow in the laboratory of Dr. Marc Montminy at the Salk Institute, she discovered a new role for the hormonal and metabolic sensor CREB and its co-activator CRTC2 in T cell development and function. In 2015, Dr. Jeniffer Hernandez joined Keck Graduate Institute School of Pharmacy as an assistant professor where she conducts research in autoimmune disease and metabolism. Dr. Hernandez also has a passion for teaching and mentoring.



Dr. Josh Yee

Dr. Josh Yee began his undergraduate studies at UC Irvine, where his passion for research in materials science and engineering under the mentorship of Prof. Farghalli A. Mohamed, one of the leading experts in superplastic deformation and creep in metals. He joined the UC LEADS program in 2009 to further explore his opportunities in academic research, while also meeting a diverse and outstanding cohort of other undergraduate scholars who share the same passions as him. Josh graduated from UC Irvine with a BS in materials science and engineering, and a BS in mechanical engineering in 2011. He then furthered his studies by pursuing graduate degrees at UC Davis under the guidance of Prof. Enrique J. Lavernia, a world-renowned researcher and leader in powder metallurgy and material processing through severe plastic deformation. He received his MS and PhD in materials science and engineering in 2014 and 2015, respectively. Today, Josh is a material engineer at Sandia National Laboratories in Livermore, CA. He is particularly active in the field of additive manufacturing, studying material properties and qualification issues. His interests outside of materials science and engineering include home improvement, gardening, bicycling, and playing with his 3-year-old son**.**

ALUMNI SPEAKERS

Levi Pilapil

Levi Pilapil attended UC San Diego for his undergraduate education in Chemistry and Biochemistry. He started his research journey in an organometallic synthesis Lab under Dr. Josh Figueroa. Excited about research, Levi joined the UC LEADs program during his second year after transferring from community college. During his first year as a UC LEADS scholar, he continued his work in the Figueroa Lab conducting research on air-sensitive synthetic processes of organometallic cobalt complexes. He attended UC Berkeley his second year and worked under Dr. Dean Toste studying novel gold-mediated catalytic synthesis of indole-3-acetates. In addition to research, Levi also took part in various research conferences such as SACNAS, ERN and ABRCMS while in UC LEADS. Upon graduating, he joined the private sector as a Process Development Chemist at a pharmaceutical company working on developing and manufacturing of controlled-substance active pharmaceutical ingredients. Levi soon transitioned into Process Development Engineering working on perinatal and COVID-19 diagnostic processes. Currently, he is enrolled in UC Riverside's Master of Science in Engineering program with a focus on Chemical Engineering.

Dr. Maha Haji

Dr. Maha Haji is a joint researcher in the Sibley School of Mechanical and Aerospace Engineering at Cornell and the Engineering Systems Laboratory at MIT. Her research focuses on utilizing multidisciplinary design optimization to develop a floating platform to provide recharging and data offloading capacity for autonomous underwater vehicles. After completing her B.S. in Mechanical Engineering and B.A. in Applied Mathematics from UC Berkeley, Dr. Haji received her Ph.D. in Mechanical and Oceanographic Engineering in 2017 from the Joint Program between MIT and Woods Hole Oceanographic Institution where she focused on the design and prototyping of a symbiotic system to harvest uranium from seawater. She has worked in industry as an engineering consultant at ATA Engineering, where she used analysis-driven design to solve problems ranging from aircraft and rockets to robotics and rollercoasters. Dr. Haji will be joining the faculty at Cornell as an Assistant Professor of Mechanical and Systems Engineering starting in July 2021, where her research group, the Symbiotic Engineering and Analysis Lab, will focus on designing offshore systems to sustainably extract resources from the ocean such as power, water, and food, as well as mineral resources key to the progress of clean energy. For more information about her work and her group at Cornell, visit https://sea.mae.cornell.edu.

Dr. Michelle Tu

Dr. Michelle Tu is a scientist turned creative entrepreneur who loves building brands rooted in sustainability, social impact, and great design. She's an advocate for females in STEM and enjoys mentoring young women entrepreneurs. Dr. Tu received her Ph.D. in Cell and Developmental Biology from UC Davis and her B.Sc. in Biomedical Engineering from UC Irvine.

ALUMNI SPEAKERS

Radha Daya

Radha Daya received her B.S. in Biomedical Engineering at UC Davis in 2015 and her M.S. in Bioengineering at UC Riverside in 2017. Her M.S. thesis studied the benefits of magnetic hyaluronic acid hydrogels for vascular tissue engineering and the benefits of utilizing curcumin as a growth factor. Although her background is in vascular tissue engineering, she has also worked in several research subfields of bioengineering including disease dynamics, drug discovery, medical device development, and diagnostics. Radha currently works at Roche Molecular Diagnostics as a Systems Engineer, her team is developing a diagnostic instrument that will allow physicians to diagnose disease through DNA and RNA quantification. Radha plans to continue her growth in the field of diagnostics.

Dr. Sonya Lopez

Sonya Lopez earned a Bachelor's, Master's, and Doctorate from the University of California, Los Angeles, in 2007, 2008, and 2012. During her graduate career, she received several funding awards, including the NSF SEE-LA GK-12 Graduate Fellowship (2011-2012), NSF Graduate Research Fellowship (2008-2011), UCLA Eugene Cota Robles Graduate Fellowship (2007-2008), and the NSF Alliance for Graduate Education and the Professoriate (Summer 2007). After graduate work, she received a Post-doctoral research appointment with Dr. Reed Maxwell at the Colorado School of Mines, working with a multi-institutional program: ReInventing the Nationals Urban Water Infrastructure (ReNUWIT). Her research areas include developing methods to ascertain the impacts climate variability has on the long-term surface and subsurface water, water storage, ecosystems, and water quality using novel modeling techniques and integrating advanced observation data. This work involves modeling studies to include local, sustainable technologies using both physically-based and conceptually-based hydrologic models. Dr. Lopez is currently an Associate Professor at the California State University, Los Angeles, within the Civil Engineering Department. Thus far, she has received over 10 million computing hours and over $6 million in research funding; she has presented at conferences within the United States and Internationally. All graduated researchers were either successfully accepted into MS and Ph.D. programs or were offered full-time engineering appointments at government agencies and private-industry companies.

Dr. Vince Lavallo

Vince Lavallo was born on base at Camp Pendleton, near Oceanside California. He obtained his G.E.D. at the age of 16 where he began to attend Palomar Community College and work full time. Subsequently he attended East LA Community College before transferring to UCR, where he earned a bachelor's degree in Biochemistry in 2005. During his undergraduate years he learned synthetic chemistry in the group of Professor Guy Bertand and was a UC LEADS Scholar. Vince spent his second summer as a UC LEADS scholar at UC Berkeley in the Lab of Professor T. Don Tilley, who he is still very good personal friends with to this day. Subsequently, he stayed at UC Riverside in the Bertrand Group and earned his PhD in chemistry in 2008. He then moved to Caltech for a postdoctoral stint in Bob Grubbs's laboratory. In 2011 he began his independent career at UC Riverside, focusing on fundamental and applied chemistry of carborane anions, and was promoted to Associate Professor in 2017. He will be promoted to Full Professor on July 1, 2021. Outside of chemistry Lavallo enjoys plant breeding/cultivation as well as off-roading and fishing.

2021 CELEBRATION OF RESEARCH PRESENTATION (LIVE)

LOCATION

Zoom Link
Password: research

First Name	Last Name	Home Campus	Presentation Breakout Room	Order in Room
Lay Heng	Teng	UC Davis	Bioengineering and Engineering	1
Lilian	Molina	UC Davis	Bioengineering and Engineering	2
Diana	Cruz Garcia	UC Merced	Bioengineering and Engineering	3
Justin	Burzachiello	UC Riverside	Bioengineering and Engineering	4
Tanner	Ragan	UC Merced	Bioengineering and Engineering	5
Aman	Kaur	UC Davis	Bioengineering and Engineering	6
Michelle	Chiu	UC Santa Barbara	Cell Biology and Physiology	1
Kelly	Chau	UC Davis	Cell Biology and Physiology	2
Angel	Garcia	UC Santa Cruz	Cell Biology and Physiology	3
Ade	Ilori	UC Davis	Cell Biology and Physiology	4
Stephany	Alonso	UC Irvine	Cell Biology and Physiology	5
Vincent	Castillo	UC Davis	Cell Biology and Physiology	6
Jojo	Chen	UC San Diego	Cell Biology and Physiology	7
Jorge	Karam Padilla	UC Irvine	Chemical Engineering	1
Sebastien	Banales	UC Riverside	Chemical Engineering	2
Matthew	Salazar	UC Santa Barbara	Chemical Engineering	3
Emily	Barragan	UC Irvine	Chemical Engineering	4
Michele	Campbell	UC Merced	Chemical Engineering	5
Eberardo	Camorlinga	UC Merced	Chemical Engineering	6
Frances	Li	UC Santa Cruz	Chemistry & Biochemistry	1
Garrett	Kukier	UC Los Angeles	Chemistry & Biochemistry	2
Victoria	Lerda	UC Merced	Chemistry & Biochemistry	3
Benito	Gonzalez	UC Santa Barbara	Chemistry & Biochemistry	4
Jessica	Salguero	UC Los Angeles	Chemistry & Biochemistry	5
Win	Teavir	UC Merced	Chemistry & Biochemistry	6
Irene	Ortega	UC Berkeley	Computers & Robots	1
Evanjelin	Mahmoodi	UC Santa Cruz	Computers & Robots	2
Myia	Dickens	UC Irvine	Computers & Robots	3
Sidney	Huen	UC San Diego	Computers & Robots	4
Kha	Nguyen	UC San Diego	Computers & Robots	5
Melissa	Lepe	UC Irvine	Earth Science	1
Sara	Perez Vite	UC Merced	Earth Science	2
Jose	Magana	UC Berkeley	Earth Science	3

2021 CELEBRATION OF RESEARCH PRESENTATION (LIVE)

LOCATION

Zoom Link
Password: research

First Name	Last Name	Home Campus	Presentation Breakout Room	Order in Room
Briana	Prado	UC Santa Cruz	Earth Science	4
Shahira	Ellaboudy	UC Santa Barbara	Microbiology & Immunology	1
RJ	Millena	UC Davis	Microbiology & Immunology	2
Mary Eloise	Fernandez	UC Merced	Microbiology & Immunology	3
Jasmine	Posada	UC Merced	Microbiology & Immunology	4
Giovanni	Lara	UC Davis	Microbiology & Immunology	5
Tessa	Chou	UC Santa Barbara	Microbiology & Immunology	6
Angelly	Perez	UC Santa Cruz	Microbiology & Immunology	7
Verenise	Martinez Lopez	UC Santa Cruz	Space & Lasers	1
Jesus	Martinez	UC Berkeley	Space & Lasers	2
Lorraine	Nicholson	UC Los Angeles	Space & Lasers	3
Eduardo	Montano	UC Irvine	Space & Lasers	4
David	Dang	UC Los Angeles	Space & Lasers	5

2021 POSTER COMPETITION ROSTER

*Abstracts are available on pages 13 - 46

First Name	Last Name	Home	Discipline of Poster Presentation
Alexander	Del Toro	UC Merced	Biological Sciences
Andy	Nguyen	UC Los Angeles	Biological Sciences
Angel	Garcia	UC Santa Cruz	Biological Sciences
Angela	Gao	UC Los Angeles	Engineering/Computer Science
Angelly	Perez	UC Santa Cruz	Physical Sciences/Mathematics
Arthor	Bernal	UC Riverside	Engineering/Computer Science
Benito	Gonzalez	UC Santa Barbara	Physical Sciences/Mathematics
Benny	Mosqueira	UC Santa Cruz	Biological Sciences
Briana	Prado	UC Santa Cruz	Physical Sciences/Mathematics
Carolina	Lopez	UC San Diego	Biological Sciences
Chris	La	UC Los Angeles	Physical Sciences/Mathematics
Christina	Puzzanghera	UC San Diego	Biological Sciences
David	Hernandez	UC San Diego	Physical Sciences/Mathematics
Diana	Cruz Garcia	UC Merced	Engineering/Computer Science
Eberardo	Camorlinga	UC Merced	Engineering/Computer Science
Eduardo	Montano	UC Irvine	Engineering/Computer Science
Emily	Barragan	UC Irvine	Engineering/Computer Science
Garrett	Kukier	UC Los Angeles	Physical Sciences/Mathematics
Giovanni	Lara	UC Davis	Physical Sciences/Mathematics
Janelle Coleen	Dela Cueva	UC San Diego	Engineering/Computer Science
Jasmine	Posada	UC Merced	Biological Sciences
Jorge	Mendoza	UC Irvine	Biological Sciences
Jose	Magana	UC Berkeley	Physical Sciences/Mathematics
Justin	Burzachiello	UC Riverside	Engineering/Computer Science
Kelly	Chau	UC Davis	Biological Sciences
Lay Heng	Teng	UC Davis	Engineering/Computer Science
Lilian	Molina	UC Davis	Engineering/Computer Science
Lorraine	Nicholson	UC Los Angeles	Physical Sciences/Mathematics
Luke	Elissiry	UC Los Angeles	Physical Sciences/Mathematics
Mary Eloise	Fernandez	UC Merced	Biological Sciences
Melissa	Lepe	UC Irvine	Engineering/Computer Science
Michaela	Warady	UC Berkeley	Physical Sciences/Mathematics

2021 POSTER COMPETITION ROSTER

**Abstracts are available on pages 13 - 46*

First Name	Last Name	Home	Discipline of Poster Presentation
Michele	Campbell	UC Merced	Engineering/Computer Science
Noah	Gaitan	UC San Diego	Biological Sciences
Pamodya	Peiris	UC Riverside	Engineering/Computer Science
Pedro	Valencia Landa	UC Merced	Biological Sciences
RJ	Millena	UC Davis	Biological Sciences
Robert	Bloom	UC Irvine	Engineering/Computer Science
Samanta	Negrete Munoz	UC Irvine	Engineering/Computer Science
Sara	Perez Vite	UC Merced	Engineering/Computer Science
Sylas	Eckhart	UC San Diego	Biological Sciences
Tanner	Ragan	UC Merced	Engineering/Computer Science
Tessa	Chou	UC Santa Barbara	Biological Sciences
Verenise	Martinez Lopez	UC Santa Cruz	Physical Sciences/Mathematics
Victoria	Lerda	UC Merced	Physical Sciences/Mathematics
Vincent	Castillo	UC Davis	Biological Sciences
Win	Teavir	UC Merced	Biological Sciences
Xavier	Perez	UC San Diego	Engineering/Computer Science

Patellar tendon injuries

ADE LLORI
UC Davis, Biological Sciences, In the Celebration of Research

Tendons are connective tissues that attach a muscle to various parts of your body, such as your bones. Tendons also convey the muscle contraction mechanical force to the bones, being that it is connected to a portion of the bone and muscle fibres. We plan to extract patellar tendons from young (day 12 post-natal), adult (9.5 months old), and injured adult (9.5 months) rats. The injured adult animals will have a small hole punched through the middle of the patellar tendon, and then the animals are allowed to walk around for days until the scar tissue forms. This injury mimics a central core patellar tendinopathy- the type of tendinopathy most common in basketball and volleyball players. RNA from these patellar tendons could be sequenced using an Illumina HiSeq 4000 platform. This platform involves bulk paired mRNA-sequencing, which reveals the sequence of every gene made within the cells of our huge dataset. With enough data about tendons made possible by analyzing plenty of tendon gene sequences, I believe that we can figure out a way to control and reverse tendon injuries. This project has the potential to change the lives of millions of people, especially athletes, around the world if we can figure out how to reverse tendon injuries.

Identifying Downstream Targets to the Interceptive SEZ Neurons (ISN) Using The Female Adult Fly Brain Electron Microscopy Volume

ALEXANDER DEL TORO, Amanda Gonzalez-Segarra, Kristin Scott, PhD
UC Merced , Biological Sciences, In the Poster Competition

Animals survive based on their ability to seek out nutrients in their environment. Regulation of consumption is based on the external nutrients available and the internal metabolic needs of the organism. The specific neural circuits underlying the primitive homeostatic drives to eat and drink remains an open question. Similar to human beings, Drosophila melanogaster regulates consumption of food and water depending on internal metabolic states. A site in the fly brain that functions as an internal nutrient and water sensor is known as the subesophageal zone (SEZ). The SEZ contains four neurons that have been shown to be sensitive to internal signals of nutrient deprivation and water abundance, which are known as the Interoceptive SEZ neurons (ISNs). ISNs have been shown to oppositely regulate sugar and water consumption, which suggests that their function is to restore internal homeostasis. The goal of this project was to utilize the Female Adult Fly Brain (FAFB) Electron Microscopy (EM) volume within The Collaborative Annotation Toolkit for Massive Amounts of Image Data (CATMAID) to trace and identify neurons postsynaptic to the ISNs. Through this software, neurons were transformed from 2-dimensional EM images into 3-dimensional neuron skeletons. Once a neuron was reconstructed, synaptic connectivity between the ISNs and postsynaptic partners could be analyzed. Our results identified 3 novel downstream neurons which provided unique insights into the neural circuits that are modulating the homeostatic drives to eat and drink.

Effects of a Public Health Intervention Program on Educational Outcomes

AMAN KAUR, Marianne Page, Ph.D., Briana Ballis, Alaa Abdelfattah
UC Davis, Physical Sciences/Mathematics, In the Celebration of Research

This project investigates the effect of the federal Special Supplemental Nutrition Program for Women, Infant, and Children (WIC) on children's academic attainment, the likelihood of being diagnosed with special needs, college enrollment, and labor market outcomes. Previous researchers have shown that WIC increases mothers' nutritional knowledge and their infants' birth weight. Another literature has linked birth weight to better health and school performance, thus we expect the benefits of WIC to spill over to children's academic success. To analyze the economic effects of the program on child development and long term outcomes will be using Texas Educational Analysis data linked to Texas birth certificates, we will estimate the associated improvements between 2005 and 2009 in the health of infants and impact on their school attendance, enrollments, test scores, and human capital by comparing children whose pregnant mothers experienced the closing and opening of WIC clinics in their neighborhoods. Additionally, we want to analyze how the health effects of WIC transmit to children's academic achievement and the overall opportunity cost and benefit of the program to the Texas school system.

Investigating the Binding of Spire/Myosin-V in Drosophila melanogaster

ANDY NGUYEN, Michelle Panzica, Margot E. Quinlan
UC Los Angeles, Biological Sciences, In the Poster Competition

Spire works with Cappuccino to build actin filaments in the cell. Both proteins play an important role in polarity establishment during Drosophila oogenesis by constructing an actin meshwork that fills the oocyte. Myosin-V is a motor protein that travels along actin filaments like those that Spire and Cappuccino construct. Previous research suggests that Myosin-V and Spire interact. The purpose of this study is to measure binding of Myosin-V and Spire and learn how it affects each of their functions. We hypothesize that Myosin-V is activated by Spire, but that the binding of Myosin-V and Spire has no effect on Spire's activity. In order to test this, we purified the two proteins from E. coli and tested their binding in a pulldown assay. We performed pulldown assays with wild type and mutated Spire and Myosin-V. We see evidence of the direct interaction in our pulldowns with wild type proteins. However, when either Spire or Myosin-V are mutated, in the predicted interaction sites, binding is greatly reduced. These results suggest that the proteins bind directly and we know the binding sites. Analysis of Spire's actin assembly in vitro coupled with in vivo data using the Drosophila oocyte as a model system will reveal the importance of the Spire-Myosin-V interaction. We predict that the disruption of binding between Spire and Myosin-V will negatively affect viability and meshwork formation in Drosophila oocytes.

Determining the Role of Fezf2 in Neural Stem Cell Lineage Progression

ANGEL GARCIA, and Jeremiah Tsyporin
UC Santa Cruz, Biological Sciences,

The cerebral cortex is the outermost layer of the brain that is essential for the high functioning capacity of the human species. The cerebral cortex contains diverse projection neurons that extend to both local and long distance targets. Radial glial cells (RGCs), also known as neural stem cells, reside in the ventricular zone of the brain. As they mature over time, they undergo a lineage switch to produce tri-potent intermediate progenitor cells that reside in the subventricular zone. These progenitor cells will go on to generate the different types of neurons and glia of the cortex, as well as olfactory bulb interneurons. The process of RGC maturation and differentiation is controlled by various transcription factors that dictate the cell's fate. A deeper understanding of the molecular mechanisms for RGC maturation can improve therapeutic treatments for when the process goes awry.

Fezf2 is a transcription factor that is expressed in late stage RGC's and deep layer projection neurons during normal brain development (Chen et al., 2005; Molyneaux et al., 2005). While Fezf2 has been suspected to act as a transcriptional repressor during RGC maturation, the exact mechanism behind it is still unknown. Loss of function mutations through Cre-Lox recombination were used to modify Fezf2's ability to function in the cortex. Our data shows that Fezf2-/- mice have increased amounts of RGCs in the ventricular zone after the differentiation period, and much less deep layer projection neurons. Fezf2 overexpression resulted in an increase in deep layer projection neurons and glia. While the project is still ongoing, our findings lead us to believe that Fezf2 restricts RGCs from developing into certain cell lineages.

Static Fingertip Force Production by a Tendon-driven Robot Finger

ANGELA L. GAO, Sruthi Mukkamala, and Veronica J. Santos
UC Los Angeles, Engineering/Computer Science, In the Poster Competition

Fingertip force production is essential for the robotic grasp and manipulation of objects. An accurate determination of fingertip force can be used to plan and enact stable grasps. In this work, we aim to model a tendon-driven robot finger using symbolic representations of a three degree-of-freedom, open kinematic chain. Using relevant geometry, we determined the manipulator Jacobian of the robot finger, which enables the mapping of tension of six tendons to fingertip force in 3D. An algorithm manifesting this relationship will be developed and tested in MATLAB using a set of known tendon tension values and their corresponding fingertip force values. Using Monte-Carlo simulation, we aim to determine the maximum fingertip force from a range of allowable tendon tension values. This resultant fingertip force can be used for planning as well as real-time control of robot hands that perform grasp and manipulation tasks without tactile sensors.

Copper dependent structural differences in a disease resistant prion protein mutant

ANGELLY PEREZ
UC Santa Cruz, Physical Sciences/Mathematics, In the Poster Competition & Celebration of Research

Neurodegenerative diseases are a class of diseases that result in cognitive impairment and are ultimately fatal. A distinctive set of neurodegenerative diseases include prion diseases. These occur when normal prion proteins in the body misfold due to a single point mutation of the prion protein gene (PRNP). Yet, these diseases are poorly understood. Our previous research has shown that a copper driven cis interaction occurs in normal wild type (WT) prion proteins that is neuroprotective. Previous NMR structural studies show side chain rearrangements that could prevent amyloid formation. Additionally, observations of a naturally occurring mutation in humans resistant to prion disease led to the identification of the G127V mutant. Studies in mice have shown that this mutation exhibits complete resistance to prion disease. We will be using the mouse mutant (G126V) to determine the if the copper driven cis interaction plays a neuroprotective role in this mutation. Two dimensional Nuclear Magnetic Resonance (NMR) spectroscopy has been used to determine if the cis interaction is altered in the mutant. By characterizing the structure of prion disease resistant proteins we get a better understanding of the mechanism involved in the formation of neurodegenerative states. This information has the potential to inform future therapeutic design.

Comprehensive Analysis of Open Source Software for Mouse Behavioral Phenotyping

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Behavioral phenotyping in mice is a common way to assess neurocognitive abnormalities in response to experimental interventions in the study of health and disease. Human assessment of video recordings of behavioral tests can be time consuming and unreliable with high interindividual and inter-institution variability that would require hours of training to make reproducible. Thus there is a need for automated, reliable scoring tools. Software suites frequently used by behavioral experts, including Ethovision XT, can be cost prohibitive. We hypothesize that open source software can reliably reproduce findings across multiple study paradigms, indicating value in application across mouse models and institutions. The aim of this study was to evaluate several open source video processing programs (e.g. ezTrack, Tracktor) to assess the best one for its ease of use and reproducibility of data. Of the programs tested, eZtrack was selected for further analysis in the present study. Behavioral metrics that were evaluated include attention, grooming, rearing, locomotor behavior, and anxiety-like behavior. Wild type C57Bl/6 specific-pathogen free mice from various experimental groups were evaluated. We identified several strengths and weaknesses associated with each method assessed and proposed a suggestion for researchers aiming to select an ideal scoring program. Ultimately, we select an open source program that best meets our criteria for ease of use and is capable of reproducing previous findings generated by hand scoring and Ethovision XT software for several neurocognitive tests of short term memory and anxiety-like behavior in mice.

Absence of moment fragmentation in the mixed B site pyrochlore oxide Nd2GaSbO7

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Nd-based pyrochlore compounds (Nd2B2O7) are of particular interest in the framework of moment fragmentation physics. Introduction of charge disorder on a non-magnetic B site in these systems is expected to reduce the symmetry about the Nd site, significantly suppressing moment fragmentation. Here we report on a polycrystalline sample of a Nd pyrochlore with a charge-disordered B-site, Nd2GaSbO7. We show that this compound orders into the “all-in, all-out” magnetic structure below TN = 1 K, one of the highest ordering temperatures reported for a Nd pyrochlore. The Ising-like character of the moments and the dipolar-octupolar nature of the ground state doublet are confirmed via bulk property measurements and crystal field analysis, respectively, both of which are necessary for moment fragmentation. Although inelastic neutron scattering results show a flat mode at 0.253(6) meV, the diffuse neutron scattering was not able to resolve any spin-ice correlations. These results may suggest the absence of moment fragmentation in this system.

Expression Levels of LincRNA-Cox2 in Resident and Recruited Alveolar Macrophages

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Advancements in RNA-sequencing have provided us with an unprecedented view of the human genome. One of the most fascinating findings is that less than 3% of the genome codes for protein-coding exons, yet more than 85% of the genome is transcribed. We are now faced with the challenge of understanding what these other RNA genes do and whether they play key roles in biological processes. The largest group of RNA produced from the genome is Long noncoding RNA (lncRNA). LncRNAs are described as transcripts greater than 200 nucleotides in length that do not code for protein. The Carpenter Lab pioneered the studies of lincRNA-Cox2, which has a dual regulatory role controlling its neighboring gene (in cis) as well as genes on other chromosomes (in trans). We have preliminary data suggesting lincRNA-Cox2 is most highly expressed in the lung. For my project, I used RNA-sequencing data of resident and recruited alveolar macrophages (AMs) harvested from an Acute Lung Injury (ALI) mouse model to determine the kinetics of lincRNA-Cox2 expression using mice treated with lipopolysaccharide (LPS) for 0, 3, 6 and 9 days. I’ve determined that lincRNA-Cox2 is thirty-two times more in recruited alveolar macrophages than residential alveolar macrophages. This is consistent with my hypothesis as lincRNA-Cox2 is critical in regulating pro-inflammatory pathways in bone marrow-derived macrophages. These data will enable us to focus our future mechanistic studies on the cell type where lincRNA-Cox2 is most highly expressed.

Discovering Organic Chemical Indicators of Environmental Conditions at the Scripps Pier

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The chemical composition of seawater has been observed to change with rain events, temporality, and the ecological distribution of microbial communities of the San Diego coast. A time series from Dec. 2014 - Jan. 2016 was analyzed using a non-targeted tandem mass spectrometry approach to characterize over 10,000 molecules off the Scripps Pier. Different statistical tools were used to identify robust trends in chemicals correlations to environmental factors. This analysis identified 100 compounds that were abundant during time periods defined by particular environmental characteristics. The identity of these compounds was examined by uploading mass spectra and comparing them to spectra in the Global Natural Products Social Molecular Networking (GNPS) library. The quality of the identification was manually examined by scrutinizing fragmentation patterns and examining existing web resources of library-IDs and analogs. The quality of identification was ranked from A-C, with A being the best match. Where library matches were partial, a further effort was made to classify compounds into general chemical classes. Primary literature provided more information on the biological, geological, and anthropogenic sources of these molecules and linked chemical composition to environmental conditions at the Pier. These data will continue to inform a global database on chemo-ecological relationships that are indicative of certain environmental conditions.

Analyzing clinician views on race and genetic ancestry for treating hypertension

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With the growth in technological advancements that allow for the quantification of genetic ancestry and the varying definitions of race, it is uncertain how clinicians utilize and value this information when developing treatment plans for patients with hypertension. In medicine, race is commonly used to represent unmeasured social, environmental, and genetic factors that may contribute to disease, despite scientific agreement that there is no biological basis to race. Racial disparities in hypertension contribute to disproportionate deaths among communities, and race-specific guidelines- that have yet to be comprehensively validated- may contribute to this disparity. The American College of Cardiology JNC8 race-specific guidelines for management of high blood pressure provide race-specific treatment plans for hypertension in Black versus non-Black patients, although there is no genetic evidence for racial differences in drug response. The goal of this ongoing observational study is to understand how clinicians use and value genetic ancestry data and race in their clinical practice when developing treatment plans for hypertensive patients. In this study, we examined data from 21 interviews with clinicians using qualitative analysis of open-ended questions regarding treatment plans and their overall belief about the role of racial classifications and genetic ancestry in their medical practice. Preliminary results indicate that while clinicians were generally aware of race-specific guidelines for choice of drug treatment, most did not follow them closely. Instead, they tended to rely on clinical experience which prioritized factors such as potential side effects and lifestyle over genetic ancestry data or race when justifying their reasons for medication choice. Furthermore, clinicians' definitions of race varied and most did not value genetic ancestry data when treating patients or classifying race. Understanding how clinicians use and value ancestry data will be valuable to advance investigations of the contentious topic of race-specific treatment of hypertension between Black and White Americans.

Kinetic Model for the Iron-Catalyzed Oxidation of Dithiothreitol

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Dithiothreitol (DTT) oxidizes into its disulfide form when it reacts with redox-active components. A 5,5'-dithiobis(2-nitrobenzoic acid) (DTNB) probe can be used to quantify the rate of DTT loss and assay the general oxidative potential of particulate matter (PM) samples. Aerosol oxidative potential is associated with adverse health effects of PM, as pulmonary inflammation induced by oxidative stress is a suspected pathway through which health issues arise from PM exposure. The chemical species that are known to be reactive in the DTT assay, such as transition metals, differ in efficiency of DTT oxidation and occur at varying concentrations in PM. The chemistry of the DTT assay is partly understood, with different reaction mechanisms having been proposed for the metal-catalyzed oxidation of DTT in regards to specific metals. However, limited literature on the rate data for several reactions involved in the DTT assay has hindered development of any kinetic models. In the present study, we made a kinetic model for the iron-catalyzed oxidation of DTT. Kinetics data on relevant reactions were compiled and results were analyzed using Kinetic PreProcessor. The model is in rough agreement with experimental data for DTT loss at varying concentrations of Fe(II) and Fe(III). The model overestimates DTT loss for low Fe(II) concentrations and underestimates DTT loss for high Fe(II) concentrations in the range of 0.5–5 μM. The model generally underestimates DTT loss for Fe(III) in the concentration range 0.5–10 μM and becomes less accurate at higher Fe(III) concentrations in that range. By developing this kinetic model, we can expand on fundamental understanding of the DTT assay and further justify its use in assessing PM toxicology.

Determining the role of predation in the evolution of sexual dimorphism in threespine stickleback

CHRISTINA PUZZANGHERA, Dianna Rennison
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The Three-spine stickleback has been known to exhibit sexual dimorphism in a variety of traits in the wild. Our research is focused on decoding what mechanisms contribute to this dimorphism. We used a controlled experiment, that manipulated environmental factors including predation to determine the effect of said factors on dimorphism. We hypotheses that sexual dimorphism in the three spine stickleback could be caused because male and female stickleback interact differently with their environment and in particular, predators.

Self Phase Modulations Scans with Neural Networks

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Short pulse lasers, with durations less than 100 femtoseconds are capable of reaching peak powers on the magnitude of the US power grid. They play an important role in modern-day science and technology, seeing use in x-ray generation, particle accelerators, and atomic emission spectroscopy. In fact, the 2018 Nobel Prize in Physics was awarded to Donna Strickland and Gerard Mourou, who discovered how to amplify short pulse lasers to high energies. Unfortunately, short-pulse lasers operate on such a short time scale, we cannot directly measure its temporal profile. One solution is to use a nonlinear optical effect called, self-phase modulation, which causes a nonlinear change in the laser's spectrum that is dependent on the temporal profile. By making well-defined changes to the temporal profile and applying self-phase modulation, we can measure changes to the spectral intensity of the lasers, known as a self-phase modulation dispersion scan (SPM-D Scan), that contains the information needed to reconstruct the temporal profile. Typically, an iterative or “guess-and-check” algorithm is used to retrieve the temporal profile; for our research, we want to apply a convolutional neural network and examine the error between the neural network’s prediction and the true temporal profile. Neural Networks hold several advantages over an iterative algorithm: real-time results, no need to wait for convergence, and the ability to analyze more complex models. In early testing of our Neural Network, our machine learning approach had a high level of accuracy in predicting the temporal profile- with 90% of tested pulses having an error less than 7.5% in their maximum temporal intensities. These early results show that neural networks are a viable way of analyzing SPM-D scans and retrieving the temporal profile.

Queen Packing on an Infinite Chessboard

DAVID HERNANDEZ
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One of the most studied mathematical chess problems involves placing pieces on a board so that they do not attack each other. Queens are particularly interesting for this problem, given that a single queen attacks the row, column and diagonals on which it is placed; they attack more squares than any other piece. A generalization of this task consists of having two distinct armies of queens such that any queen from one army is not attacking a queen from the other army. As the size of the board gets larger, a reasonable approach is to find the configuration of queens that attacks the least number of squares, so that the opposite army can be placed in those spots that are not being attacked. By packing the queens together, we force them to attack common squares, consequently reducing the total number of cells attacked. In this project, we study the behavior of configurations of queens on an infinite chess board. We look to maximize the number of queens and minimize the number of rows, columns and diagonals attacked. We find the ideal configuration of queens and the optimal rate of queens to rows, columns and diagonals attacked that results from said arrangement.

3-D Vessel Formation by Stem Cell Co-Differentiation

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As the fields of tissue engineering and drug discovery transition towards using larger organoids, they are limited by integration with perfusable blood vessels. Thus, the need for developing perfusable vascular is mounting. Using a polydimethylsiloxane (PDMS) microfluidic devices, perfusable blood vessels have been generated by seeding human aortic endothelial cells (HUVECs) and normal human lung fibroblasts (NHLFs) within fibrin or collagen gels, however, these vessels do not integrate with other cells/tissues. This study examined the ability to co-differentiate both endothelial cells (ECs) and smooth muscle cells (SMCs) from a population of mouse embryonic stem cell (ESC)-derived vascular progenitor cells (VPCs) within our 3D microfluidic device. Using our two-step serum-free induction protocol for EC derivation, we have explored different matrix combinations (fibrin, fibronectin, collagen I & IV) that co-direct VPCs into neo-vessel structures. The VPCs have been observed to degrade the matrix within the various matrix combinations. This research explores the co-differentiation of multiple tissues that can later be incorporated in the development of larger organoids.

KOH Etching to Increase Zorflex Energy Capability

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The electric double-layer capacitor (EDLC) is one of many attempts to increase long-term energy storage in supercapacitors. These are highly investigated due to their electrostatic storage and long cycle life. A well known electrode material for these supercapacitors is activated carbon. Carbon cloth zorflex, a material chosen for EDLC electrodes, is an efficient material due to its natural porosity. However, the electrical conductivity is low. As an effect, it makes the electrons generated during charging difficult to make their way from charge carriers to the circuit. For better conductivity properties, there needs to be an increase in the specific surface area on the zorflex. The KOH activation process increases the area significantly through an intercalation reaction. After the metallic potassium intercalates into the zorflex, it is removed by HCL leaving small pores and different disfigurations on the surface. The main focus of this research is to find an appropriate concentration of KOH solution and take into account the amount of KOH the zorflex absorbs while the research scrutinizes the effects of metal-catalyzed graphitization to increase the low conductivity.

Kinematic Design of Deployable Structures with Low Actuation Requirements Based on Pop-Up Origami

EDUARDO MONTANO, Edwin Peraza Hernandez
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This poster establishes the design of a structure based on a mechanism that deploys said structure from a compact two-dimensional configuration to a three-dimensional space with a single degree of freedom actuation mode, the deployment is inspired by pop-up books mechanisms. An algorithm identifies the target shape for the desired structure, and a matrix that contains a number pertaining to each individual pop-unit is recorded. The matrix creates quadrilateral pop-up units stacked in an array format that approximates the target shape depending on the opening angle of the structure. The length and width of each pop-up unit are provided, along with its opening angle. Trigonometric equations are utilized to obtain the position of each vertex of the pop-up units with respect to the Cartesian plane. Four pages based on the four quadrants along the Cartesian plane are created and restricted by their corresponding opening angle, allowing the pop-up structure to open up to 360 degrees. Three-dimensional structures are obtained by the expansion of pages through different sections through the z-direction. The algorithm qualifies the accuracy of the structure by comparing the area and volume of the target shape and the obtained structure. Originally, the structure will be open to the rest angle that it is assigned. Therefore, a strain energy equation is developed based on the energy required to close the pop-up units of the structure at each respective opening angle.

COMSOL Simulation of Gaseous Methane Rising in a Molten Salt Column Reactor

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Power and heat production via the combustion of fossil fuels is the world’s most widely utilized energy transformation process. Complete hydrocarbon combustion exacerbates climate change by producing CO2 which is typically released into the atmosphere. Fossil fuel resources can be used without producing CO2 by partial oxidation in the absence of oxygen (pyrolysis). Such a process has been demonstrated with methane from natural gas using high temperature liquid catalysts in a bubble column reactor. In order to effectively study these catalytic reactions, especially during a global pandemic where remote research is encouraged, a virtual simulation of the bubble column reactor was established. This research focuses on the use of computational fluid dynamics (CFD) and finite element analyses in COMSOL Multiphysics® to reproduce the physical attributes of a gaseous methane bubble rising and reacting in a column of molten salt. In this research, a time-dependent study with phase initialization was implemented to observe the interactions between the bubble and liquid medium. A user-defined mesh of varying element sizes and shapes was applied to geometry of a column of water with a single air bubble. Regions that contained steep solution gradients were densely populated with triangular elements while regions that experienced relatively small changes were populated with sparse, quadratic elements. Convergence was achieved using microsecond time scales. Comprehensive investigations of solutions from this simulation can be used to motivate knowledge regarding catalytic reactions in a partial oxidation natural gas reactor. As a result, more streamlined reaction systems may be actualized and implemented.

Towards an Accessible Immersive Virtual Reality Experience for Coping with Anxiety and Obsessive-Compulsive Disorders

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Anxiety disorders are one of the most common mental illnesses among the general population. Traditional treatments for anxiety therapy may be too traumatic, not strong enough, or cause relapses in patients. This research examines a new way to look at treatment for anxiety disorders: Virtual Reality (VR) experiences. Through proposed methods of VR experiences including ones targeting fear of germs, social anxiety, and repetitive tasks, as well as data collection, we suggest ways in which VR may be an effective way to go through exposure therapy for people diagnosed with anxiety disorders.

Carbon Cloth Supported Bismuth-Based Electrocatalysts for Artificial Nitrogen Fixation

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Ammonia is not only an essential ingredient in fertilizer for agriculture to sustain the world's ever-increasing population, but also is a promising energy carrier. The industrial Haber-Bosch process that currently dominates the ammonia synthesis process generates more than 300 million metric tons of carbon dioxide annually and depletes 1% of the world's energy supply. In contrast, artificial nitrogen fixation through electrocatalysis has become an increasingly desirable method of ammonia generation as the use of renewable electricity in this process is helpful to realize zero carbon emission. In this project, we developed carbon cloth supported bismuth based electrocatalysts aiming at improving the intrinsic activity of bismuth. We also provide a strategy to scale up the production of catalysts for artificial nitrogen fixation.

The Highly-Favored Orbital-Symmetry-Forbidden Electrocyclization of Vinylogous Sesquifulvalene

GARRETT KUKIER, Aneta Turlik, Xiaosong Xue, and K.N. Houk
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The origins of regioselectivity and diastereoselectivity in the electrocyclization of vinylogous sesquifulvalene (heptafulvene attached to fulvene at the exocyclic carbons) have been elucidated by density functional theory calculations. The 14π electrocyclization to form a tetracyclic product oc-curs through the “symmetry forbidden” conrotatory pathway to form trans-10a,10b-dihydrophenazulene. Computational studies reveal that formation of the trans product is kinetically favored compared to formation of the cis product, which would proceed through a disrotatory pathway. The transition state for formation of the trans product is also more energetically favorable than those associated with formation of products arising from the available 10π, 8π, and 4π electro-cyclizations, leading to formation of only a single regioisomer and diastereomer. The calculated free energy barriers are in accordance with experimental results by Prinzbach. The origins of this dramatic violation of the Woodward-Hoffmann rules are examined.

Determining the Binding Affinity of SARS-CoV-2 Spike Protein Fragment to Heparin

GIOVANNI LARA, Roland Faller
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The novel coronavirus SARS-CoV-2, which causes the COVID-19 disease, has created mass lockdowns world-wide due to its high transmission rate and lethal nature. It is well documented that the SARS-CoV-2 spike glycoprotein interacts with receptor ACE2 in order to enter cells to start replication. Recent research [1] suggests that the glycosaminoglycan heparin which is also present in most mammalian cells may be able to bind to the SARS-CoV-2 spike glycoprotein, this can lower transduction efficiency in cell culture. To validate this interaction, a SARS-CoV-2 spike glycoprotein fragment and heparin are tested in silico to find binding affinity by measuring the relative distances between the molecules at various time points. High binding affinity may reveal potential in heparin and its derivatives as drugs to reduce transfection rates.

Computer-Based Testing

IRENE ORTEGA
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In STEM higher education, courses conduct both formative and summative assessments in a manner that hinders mastery learning and magnifies equity gaps in student preparation. STEM courses adhere to constant time pacing with variable learning, which is the same for all students regardless of learning speed. In contrast, mastery learning is “constant learning over variable time”—some students may take longer than others to reach the same level of mastery, but they can eventually do so with increased practice and instructor support. The challenge with implementing mastery learning is that increased practice in STEM courses means solving more practice problems, but developing good practice problems requires instructor effort, to say nothing of giving the students feedback on their performance on those problems. To address these challenges, the Ace-Lab at UC Berkeley has adopted a flexible and extensible question asking platform named PrairieLearn from the University of Illinois to develop question generators that enable both online formative-assessment mastery learning and summative-assessment mastery learning for “The Beauty and Joy of Computing.” Question generators will create new question variants on demand and give the student immediate feedback on their answer. Students will have as much practice and time with Snap! and Python concepts as necessary to achieve mastery rather than a rigid schedule that may result in variable learning outcomes. Our hypothesis for this project is that question generators will result in higher retention, stronger learning outcomes, higher participation in computing for underrepresented and minority students, and more effective use of instructor time to identify and assist struggling students.

Application of novel impactor in the nondestructive evaluation of composite aerospace structures

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The development of nondestructive evaluation (NDE) techniques to detect and quantify impact damage will be able to produce insight into the current lifetime of composite aerospace composites. Composite structures are prone to barely visible damage (BVD) which necessitate impact hammers to assess the viability of the structure. Industry integrated impact hammers generate a restrained excitation frequency of below 30 kHz. The parametrization of a unidirectional novel mini-impactor composite beam capable of producing an excitation with a frequency range between 40 – 500 kHz for impact force, frequency, and time-domain features was conducted. High-speed imaging, piezo contact sensors, and finite element analysis were utilized to acquire impactor parametrization data. The mini-impactor constructed with a user-defined stiffness was used to actuate an excitement in variable materials, material geometry, and material impairment. Ultrasonic guided wave measurements quantified were found to vary in damaged and pristine structures.

The Impact of Maternal Infection on Fetal Cytokine Repertoire

JASMINE POSADA, April C. Apostol, Anna E. Beaudin
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In adulthood, hematopoietic stem cells (HSCs) reside in the bone marrow and generate all the blood and immune cell lineages in the body. During infection, inflammatory signals directly influence HSC function, but little is known about how maternal inflammation shapes fetal hematopoiesis. Recent evidence from our lab indicates that maternal infection evokes expansion of fetal HSCs and impinges on HSC function. We hypothesize that these changes occur as a direct response to alterations in the fetal inflammatory cytokine repertoire. In order to investigate fetal cytokines following maternal infection, we injected pregnant C57BL/6J mice with a low-dose of Polyinosinic:polycytidylic acid (Poly I:C), a viral mimetic. One day following infection, levels of inflammatory cytokines were assessed in fetal liver supernatant and amniotic fluid using a multiplex immunoassay. We observed an upregulation of key cytokines such as IFN-B, IL-27, and IL-1B in the fetus in response to induced maternal inflammation. We now aim to build on these results, gain insight into how changes to the fetal environment are influenced by maternal infection, and define the critical mediators that have a lasting impact on immune development and function across the lifespan.

Members of Star Cluster G286.21+0.17

JESUS MARTINEZ, Jessica R Lu
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Star cluster G286.21+0.17 is an intergalactic star-forming massive cluster approximately 2.5 kpc away. Its young age and large mass makes it a great candidate for testing star cluster formation theories answering questions, such as, which factors decide star formation efficiency and what are typical star cluster formation time scales. Given its importance, it is important to first establish its cluster members by studying the cluster's kinematics. In this presentation, we study kinematics of Hubble Space Telescope data retrieved through WFC3/IR imaging in filters F110W, F128N, F130N, F160W, and F167N to assign stellar proper motions. This is then fed into a statistical analysis using Gaussian Mixture Modeling in order to identify cluster members.

based shifts in metabolic machinery

JESSICA SALGUERO, Janine Y. Fu, Robert P. Gunsalus, Rachel R. Ogorzalek Loo, and Joseph A. Loo
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Acetomicrobium hydrogeniformans OS1 is an anaerobic microbe of the Synergistes phylum that lives in the harsh conditions of oil production water streams and industrial wastewater. This bacterium exhibits efficient conversion of glucose into hydrogen that approaches the theoretical limit, where six-carbon sugars are broken down into almost four molecules of hydrogen. We hypothesized that glycolytic proteins would be present at different abundances in alternative non-glucose-only media because these alternate growth conditions contain different non-fermentable carbon sources. To better characterize A. hydrogeniformans' unconventional metabolic pathways and to test whether different carbon-based culture conditions would affect expression of metabolic proteins, cells were grown in one of five culture conditions: glucose-only, pyruvate-only, glutamate-only, glucose-pyruvate, or glutamate-pyruvate mixtures. Proteins from each growth condition were isolated from cell lysates, identified through liquid-chromatography tandem mass spectrometry (LC-MS/MS) and their relative abundances were quantified, an approach collectively termed bottom-up proteomics. Comparisons of protein type and abundances were made between the glucose-only and the other growth conditions. This comparison is particularly valuable since the high rates of A. hydrogeniformans' fermentative hydrogen production in nature were seen in the presence of glucose alone. Initial analysis has revealed that different culture conditions have an effect on the proteomic profile of metabolic processes and the protein expression levels of these microbes, with expression of different proteins either increasing or decreasing in each of the alternative carbon sources. Mapping the upregulated and downregulated proteins to their specific metabolic pathways have revealed that multiple important processes involved in energy consumption, like glycolysis and gluconeogenesis, were largely affected by these differing growth conditions. Future research of these metabolic pathways will allow deeper understanding of the mechanisms responsible for A. hydrogeniformans' energy efficiency, which can be applied towards the creation of more efficient biofuels.

Prosocial Rat Behaviors

JOJO CHEN, Emily Winokur, Dr. Laleh Quinn, Dr. Federico Rossano, and Dr. Andrea Chiba
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Rats exhibit a great amount of social behavior in their natural environment. This presentation will identify subtle behaviors that the rats exhibited when placed in a novel laboratory paradigm designed to study prosocial behavior. Moreover, this presentation will include a description of how the behaviors are exhibited, why the rats show these behaviors, and the importance of studying these behaviors in our experiment and how it can relate to their general social behavior.

Mechanical Analysis Of PVA Nanofiber Mats For 3D Hydrogels

JORGE KARAM PADILLA
UC Irvine , Engineering/Computer Science, In the Celebration of Research

This experiment introduces the study of the advantages of electrospinning on water media. The use of this technique involves the production of long nanofiber mats from a poly(vinyl alcohol) (PVA) solution, a substance that has acquired special attention in fields such as drug delivery for its excellent physical properties (biocompatibility and water solubility). With this method, we were able to analyze the mechanical and chemical properties of these microfibers mats by electrospraying from a PVA solution drop under the influence of a potent electric field.

Using chemogenetics to manipulate Lateral Habenula activity

JORGE MENDOZA, Oriol Lucie., Warlow Shelly. M, and Hnasko Thomas S.
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Abnormal activity in the Lateral habenula (LHb) is associated with a variety of neuropsychiatric disorders. For example, LHb hyperactivity is observed in patients with depression, while chronic hypoactivity may precipitate the onset of manic episodes in bipolar disorder. In rodents, pharmacological or optogenetic stimulation of LHb is aversive, and causes depressive-like behaviors. Thus, balance of LHb activity may be important for normalized motivation. The LHb receives GABA/glutamate co-release from several inputs, including ventral tegmental area (VTA) and entopeduncular nucleus of basal ganglia, both of which may play a role in balancing LHb activity. Here we sought to validate the use of chemogenetics in altering LHb activity to cause hyper- or hypo-activity. We injected either excitatory (hM3dq) or inhibitory (hM4di) DREADD (designer receptors exclusively activated by designer drugs) constructs into the lateral habenula of female and male mice. After systemic intraperitoneal injections of clozapine n-oxide (CNO; 1mg/kg) to activate DREADD receptors, Fos protein expression was quantified in LHb using ImageJ software. Our results support the hypothesis that DREADD stimulation can alter LHb activity. Thus, a chemogenetic approach towards manipulating LHb activity can be a useful tool in understanding how imbalanced LHb activity leads to pathological motivations and allow for future experiments to probe the effect of VTA inputs on balancing motivation.

Stress Drops Calculations of the Ridgecrest Aftershock Sequence of 2019 Based on Finite Source Analysis

JOSE MAGANA, Douglas Dreger, Taka'aki Taira
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The connection between the strength of tectonic faults and the earthquake rupture is central to studies of the physics of earthquakes. Ross et al. [2019] report that much of the sequence occurred on a complex network of orthogonally oriented faults that were previously unknown, and finite-source models of the M6.1 foreshock and M7.0 mainshock (e.g. Kang et al., 2020) report slow rupture velocity suggesting a relatively high fracture energy in rupturing an immature and geometrically complex fault. Here we investigate the stress drop of the aftershocks comparing with estimates from finite source models of the foreshock and mainshock. We use an empirical Greens function (EGF) derived moment rate function inversion method (Mori and Hartzell, 1990; Dreger, 1996) to determine the causative rupture plane of aftershocks, the slip distribution and the stress change (e.g. Ripperger and Mai, 2004). Possible EGF events will be identified through relative event location, cross-correlation, and recovery of moment rate pulses from the EGF deconvolution. Seismic moment tensor solutions will be reviewed or determined as needed for specific target and EGF events, and both possible nodal planes will be tested in the moment rate inversion (e.g. Mori and Hartzell, 1990). The derived best fitting fault planes and slip distributions will be used to determine the stress change (Ripperger and Mai, 2004). We will explore the rupture area and slip scaling of the sequence and compare with existing scaling relationships and results for different earthquake sequences.

Quartz Tuning Fork Sensor for Atomic Force Microscopy (AFM)

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Characterization of nano materials requires highly sensitive techniques to probe the material properties on the nanoscale. In this work, we aim to implement a force sensor that can be used in atomic force microscopy (AFM) to detect the minute forces when a probe makes contact to the sample surface. This sensor is based on a quartz tuning fork resonator whose resonance frequency changes in response to the external force. Using a combination of analog hardware and an NI myRIO FPGA board programmed with LabVIEW software, we have developed an FPGA-based lock-in amplifier and phase-locked loop (PLL). These instruments can be used to both characterize the resonance parameters of the tuning fork sensor and track its resonance frequency during AFM operation. Further development is in progress to investigate how the tuning fork's parameters affect the performance of the PLL frequency tracking. Understanding this will help us improve the tracking speed and measurement quality when used in an AFM experiment.

Predicting cell-type specific microRNAs from single cell chromatin accessibility data

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The adult human brain is composed of billions of cells, with highly specialized cell types that are defined by distinct patterns of gene expression. With the advances in single cell technology, there has been a global effort to generate a complete ‘Census’ of cell types to better understand the ‘building blocks’ of the human body. During development, cell types gain privileged access to parts of the genome, and recently developed technologies using assay for transposase accessible chromatin using sequencing (ATAC-seq) can now be applied at single cell resolution. ATAC-seq identifies parts of the genome that are “accessible” and can reveal a cell’s hidden map of chromatin state. More powerful than transcriptomics, chromatin accessibility has the predictive ability to reveal gene regulatory networks that underlie distinct cell types and can also serve as a reporter of gene expression, which is especially useful when features such as noncoding RNA are not represented in transcriptomic datasets. By integrating chromatin accessibility datasets from different stages of brain development, the genomic signature of cell types as they undergo development can be better understood.

A direct comparison of computational models for prosthetic vision

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Age-related macular degeneration and retinitis pigmentosa are pathological ophthalmic changes that lead to the loss of retinal photoreceptors. These diseases cause vision deterioration in more than 15 million people worldwide. Although currently there is no proven clinical treatment, several experimental therapies have been proposed, one of which is retinal prostheses. Retinal prostheses contain a grid of electrodes that provides electrical stimulation to the remaining nerve cells, causing patients to see flashes of lights called phosphenes. Several models have been proposed over the years to try to predict the phosphenes resulting from a given electrical stimulation in the Argus Retinal Prosthesis System (Second Sight Medical Products, Inc.). However, these models were never tested on the same data, so it is difficult to weigh the weaknesses and strengths of each model. Using pulse2percept, an open-source Python package for bionic vision, we reproduced phosphene predictions described in Horsager et al. (2009) and Nanduri et al. (2012), which estimate an electrode's threshold current and brightness from frequency, pulse duration, and amplitude of the electrical stimulation. Using the same stimuli and conditions, we calculated the coefficient of determination (R2 score) to draw a direct comparison between models. We found that Horsager et al. (2009) better predicted temporal phosphene properties than Nanduri et al. (2012), but that both models were unable to predict a large fraction of the variance in the data (Horsager: R2=-1.94, Nanduri: R2=-3.36). These results indicate that a computational model to predict phosphene appearance remains elusive. We hope that in the future, based on our analysis of these models, new phosphene models that can overcome any discovered shortcomings will be created to aid the design of retinal prostheses.

Computational Simulations of Dry Aerosol Drug Delivery in the Avian Respiratory System

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One method to treat fungal disease in the lungs of mallard ducks involves using a liquid atomizer that produces a spray. However, that method has been shown to result in asymmetrical drug delivery due to a high momentum spray jet. To address the asymmetric delivery, we are developing a dry powder insufflation device that will allow for the drug to have a better penetration and more symmetric distribution in the lungs. To assess the development of the device, we numerically modelled the behavior of the spray inside the trachea. We create a model of a trachea, using an idealized cylindrical geometry to validate the numerical modeling approach. The mallard duck breathing rate during the day is 34.9 mL/min, which results in a calculated Reynolds number of approximately 36. The spray injection velocity is high and the flow is unsteady. Thus, the governing equations used are the unsteady Navier-Stokes equations. They are solved using the open source library, OpenFOAM, which uses a finite volume approach. First, we run a mesh sensitivity study to determine the mesh resolution, then introduce a spray model to capture the medication insufflation process. To model the spray, we use the multiphase particle-in-cell (MPPIC) method to track Lagrangian pointwise solid parcels that mimic the solid spray injected by our device. We find that MPPIC is sufficient to capture the bulk spray distribution at the trachea outlet with the appropriate Reynolds number derived from the basal breathing rate for a mallard duck.

The Investigation of Noise Levels in Transabdominal Pulse Oximetry

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Current technology to retrieve fetal information involves modalities such as Electronic Fetal Monitoring (EFM) and Cardiotography (CTG). Both EFM and CTG are used in antepartum to detect fetal complications such as Hypoxia. With the spread of EFM, we have also seen an increase in emergency C-sections, providing low specificity in fetal-well being. Transabdominal Fetal Oximetry (TFO) involves a system prototype comprised of a multi-detector optode, embedded optode control system, and a customer user-interface software, aimed to produce more accurate information on fetal well-being and reduce the number of surgical interventions. TFO will measure the relative amount of oxy generated hemoglobin in blood by analyzing changes in light intensity caused by pulsating arterial tissues of both fetus and mother. In this paper, we will discuss how we approach the mixed signal problem of both mother and fetus and maximize the fetal signal. The purpose of this study is to evaluate the use of the Fourier Transform in reducing noise levels in spectral analysis of coupled fetal and maternal signals to capture fetal oxygen saturation values in a hypoxic fetal sheep.

The Effect of Evolving Luminosity on the Evolution of Small Exoplanets

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Over 4,000 exoplanets have been discovered in the past 25 years. Discovery methods include the transit method, radial velocity method, spectroscopy, direct detection, and others. These methods reveal many characteristics of the planet and its host star such as their radius, mass, chemical composition, and densities. One of the most interesting recent observations has been that while planets between the size of Earth and Neptune are quite common in our galaxy, there are very few planets of sizes 1.5-2.0 Earth radii. This lack of intermediate sized planets is referred to as the ‘radius valley’ or ‘radius gap’. Intriguingly, the planets smaller than 1.5 Earth radii are rocky and Earth-like (super-Earths), while the planets larger than 2.0 Earth radii likely have large atmospheres like our Neptune (sub-Neptunes). One hypothesis to describe the occurrence of the radius valley is the Core-Powered Mass-Loss (CPML) mechanism, in which a planet’s internal energy, over hundreds of millions of years, can potentially ‘evaporate’ its atmosphere. If a planet does not meet the conditions to trigger CPML then it will keep its entire atmosphere. Consequently, this results in two types of planets: smaller rocky super-Earths with no atmosphere and larger sub-Neptunes with big atmospheres. CPML models are able to recreate the observed radius valley fairly accurately (Ginzburg et al. 2018, Gupta & Schlichting 2019). This mechanism depends on the bolometric luminosity of the host star but the current models assume that this luminosity is always constant . While this is true for Sun-like stars, luminosities for stars like TRAPPIST-1 which are smaller than 0.1 times the mass of the Sun evolve by more than one to two orders-of magnitude during the first few billion years. In my talk, I will discuss if and how the evolving luminosity of low mass host stars affect their planet’s evolution under the CPML model. Low mass stars are not just much more common than Sun-like stars, making it easier for us today to find Earth-sized planets around them, but the TRAPPIST-1 system specifically has several Earth-like planets in its habitable-zone and is therefore one of the best candidates in our search for a planet with habitable conditions outside of our Solar system. For these reasons it is critical to better understand planet evolution around such low mass stars, specifically the TRAPPIST-1 system.

Tuning Second Coordination Sphere Interactions in Iron Pyridyl Complexes to Enhance Catalytic Properties

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Electrochemical CO2 reduction is a desirable approach to access value-added carbon-based chemicals through the capture and reduction of greenhouse gases. Biological and heterogeneous catalyst for electrochemical CO2 reduction often exhibit a high degree of delocalization that serves to minimize overpotential and maximize selectivity over hydrogen evolution. This approach has been applied to a molecular iron(II) polypyridyl complex that incorporates a terpyridine moiety into its framework which facilitates strong metal-ligand exchange coupling resulting in CO2 reduction catalysis at extremely low overpotentials. Against this backdrop, we employ a bio-inspired approach to modify the second coordination sphere of the terpyridine ligand with protic and aromatic functional groups and systematically investigate their structural and catalytic properties with computational methods. Density functional theory (DFT) electronic structure calculations were used to predict the geometry optimized structures, orbital energies, reduction potentials, and CO2/CO binding energies for the dicationic and two-electron reduced coordination complexes across the entire series. Comparative evaluation identified the quinoline, alcohol, and methylene amino appended derivatives as attractive synthetic targets due to their favorable enhancements over the parent complex. This study illustrates the predictive power engendered by computational chemistry to screen the electronic structures and probe a wide range of second coordination sphere interactions to develop an enhanced catalytic system.

Diminished Antibody Responses in Toll-Like Receptor Knockout Mice Infected by Toxoplasma gondii

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Toll-like Receptors (TLR) detect microbial infection and are participants in the induction of the host's immune system against the intracellular parasite Toxoplasma gondii, which infects most warm-blooded animals. Knocking out TLRs can allow us to recognize how the immune response to T. gondii is regulated by TLRs and whether TLRs are necessary for host survival to infection. Our lab has discovered that unlike normal mice, vaccination in Tlr2-/- and Tlr4-/- mice ('knockout mice') succumb to T. gondii infection with a virulent strain. We hypothesize that TLR2 and TLR4 are required for mouse viability because they are necessary for the intensity and presence of parasite-specific antibodies. We begin by preparing 2-day HFF passages for the parasites. The parasites were fixed and plated onto titrated serum wells with 5 different dilutions. The serums are from Tlr2-/-, Tlr4-/- and wildtype mice either vaccinated or naturally infected with a low virulence strain, conditions that promote immunity in normal mice. After incubation, plates were stained with secondary antibodies specific for various mouse isotypes (IgM, IgG3, IgG1, IgG2b, and IgG2a). The samples are analyzed through flow cytometry to reveal how the antibody isotypes are affected by knocking out TLR2 and TLR4. Here we show that TLRs are necessary for the presence of parasite-specific IgG1 antibodies. These results will allow for future studies aimed at discovering the mechanism and pathway that relate TLRs and antibodies in immune responses to infections of Toxoplasma gondii, and hopefully how to create a vaccine for parasites.

Formation of Solid Carbon on Molten Salt Surfaces by Pyrolysis of Hydrocarbons

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The pyrolysis of hydrocarbons produces hydrogen gas and solid carbon; the hydrogen gas produced can be used as a fuel source that does not release carbon dioxide when combusted. During the pyrolysis of methane in a molten salt catalyst, small particulates can be seen flowing in the molten salt. The purpose of this project is to understand the composition of these particulates and better understand the morphology of carbon in a molten salt catalyst.

Sustainability in Mining

MELISSA LEPE
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Renewable energy as a whole has been a work in progress in many industries at a worldwide scale. In the United States, the transportation sector has begun to adapt to hybridized and electric vehicles. The mining sector is a provider of many metals and minerals used in renewable equipment as well as sources of coal, metal and mineral composites for other industries. However, we see little to no efforts within the United States to decarbonize this area. Is a zero-emissions mine possible and viable for the future?

Optimization of Primality Tests and Factorization Algorithms

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Primality tests and factorization algorithms are widely used in many areas, perhaps most notably in cryptography. There is a constant struggle to keep current cryptographic methods secure against ever-improving attacks. The speed at which very large numbers can be proven prime or otherwise factored plays an integral role in the security of these systems, so algorithm optimization is necessary for both security and designing attacks. This project consisted of looking at existing primality tests and factorization algorithms, implementing them using Python and SageMath and determining ways to improve their speed and performance. After working with many different approaches to factorization, it appears that the methods that rely on generating many smaller congruences, such as the Continued Fraction Method (CFRAC), the Quadratic Sieve Method (QS) and the Multiple Polynomial Quadratic Sieve Method (MPQS), are the most efficient. Not only can small congruences be generated in many ways, as is evidenced by the existence of so many algorithms based on this idea, but the generation of these congruences can be run on different processors in parallel, making the algorithm even more efficient. Thus, because these factorization algorithms use strategies that lend themselves to optimization, new factorization algorithms should be designed to take advantage of their approaches while integrating new ideas.

Photocatalytic Reaction Testing System for Dye Degradation

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The unique layered structure of bismuth oxybromides makes them a promising candidate as a nanoscale photocatalyst that is environmentally benign. Their tunable band gap with a range of 2.3 – 2.9 eV, depending on stoichiometry, allows for photocatalytic activity under visible light, opening up the possibility of their use for solar photocatalysis. In order to assess the viability of lab-synthesized oxybromides for this application, performance assessment in a photocatalytic reaction testing system using dye degradation is required. The current project focuses on determining and designing the best testing system for photocatalytic performance of synthesized oxybromide nanosheets under visible light. The testing system requires multiple components such as a light source, reaction vessel, standard dye (i.e. RhB), and in situ or ex situ spectroscopic measurement of dye degradation. Based on a review of the literature and documentation of performance testing systems a comparison was made of various options based on factors such as cost, safety, accuracy, sensitivity, specificity, ease of use, simplicity, and feasibility of the system. Based on minimum requirements for these criteria, three candidate systems were selected and considered. For the highest scoring system, a design was drawn up and a step-by-step testing protocol detailed. Materials for construction of the testing system were identified, sourced, and priced. Future work will involve construction and validation of the testing system and its incorporation into ongoing lab research projects.

Cataloguing MUTYH glycosylase variants: functional consequences, association with disease, protein-protein interactions, and allele frequency

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Disease-causing mutations can arise from damage-induced DNA coding errors. One highly mutagenic DNA lesion is 8-oxoguanine (OG), which results from oxidative DNA damage on a guanine base. Instead of pairing the OG base with cytosine (C) during DNA replication, replicative DNA polymerases insert an adenine (A) base opposite OG, which can cause G:C →T:A transversion mutations. To maintain the integrity of base pairing, the cell has various tools to combat mutations; one of these tools is the enzyme MutY glycosylase homologue (MUTYH). MUTYH is a base excision repair (BER) enzyme that can recognize these OG:A mispairs in the genome and excise the erroneous A, forming an apurinic (AP) site. The AP site is then repaired by downstream BER machinery to restore the proper G:C pairing. When MUTYH cannot perform its reparative function, G:C → T:A mutations accumulate in the genome. Mutations in the MUTYH gene are associated with colorectal polyposis and a high risk of colorectal cancer, with a corresponding syndrome termed MUTYH-associated polyposis (MAP). While there are over 250 recorded protein variants of MUTYH that have been found in patients, it is still unclear whether the variants are directly associated with disease, and if so, how they affect MUTYH-mediated repair. To improve predictions of health consequences by germline mutations in MUTYH, as well as predictions of affected protein interactions with BER machinery, we developed a catalogue of MUTYH variants. By utilizing the Leiden Open Variation Database, ClinVar, the Genome Aggregation Database, and relevant literature, we collected the mutational variants of MUTYH and information on the effect of the variant on adenine glycosylase and mismatch recognition functions, any associated health consequences (including MAP or other diseases), interaction with BER proteins, and allele frequency.

The Steerable Walking Robot

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To improve the performance of a robot walker, The Steerable Walker project is tasked with designing and building a steerable mechanism. With this mechanism, the walkers should be able to turn left and right as well as the speed of forward and backward should be controlled. The current steering mechanism for the walkers was manufactured on the UCI campus using a laser cutter and 3D printer, while the drive train system was extended using store bought parts. Prototype A, the current model of the steerable walker, can currently move forward and left and right; however, due to space and power constraints, these movements cannot be performed simultaneously.

An Examination of Potential Uses for Radiation Sensitive Graphene Based Nanocomposite Films and Electrical Resistance Tomography in Medicine and Nuclear Power

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Electrical Impedance Tomography (EIT) and Electrical Resistance Tomography (ERT) have been used since the late 1970s in medical imaging to provide real time images of the body (e.g. [1]), and in geology as a way to image subterranean features (e.g. [2]). In EIT/ERT, a current (alternating current in EIT, direct current in ERT) is injected along the boundary of a conductive material. The result is a 2D map of conductivity changes in the internal domain, which is the result of a process requiring the experimental measurement of voltages along the boundary, the solution of an ill-posed inverse problem with filtering/smoothing. In 1993 a non-destructive evaluation technique was presented to detect the cracks in an engineered material [3]. That work led to the use of ERT as a non-invasive, non-destructive means for testing engineered structures for strain and other damage types. More recent research has demonstrated the ability of graphene-based nanocomposite films combined with ERT to provide a measurement of UV exposure [4]. Work has subsequently been done to expand the range of sensor materials to include more economic and readily-accessible options. This work continues the testing of a sensor system concept developed at UC Davis for NASA. This sensor can provide intensity as well as spatial distribution measurements of radiation exposure. This work also discusses how these properties can be utilized for other applications, namely to increase safety in medical imaging and radiation treatment, as well as in nuclear reactors.

Investigating the effects of integrin β7 blockade in an interleukin 10 (IL-10) deficient model of chronic colitis

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Ulcerative colitis (UC) remains a formidable health complication that affects roughly 10 million people internationally. UC identifies as chronic colonic inflammation through environmental and genetic factors that trigger an irregular immune response. A therapeutic strategy for UC is the blockade of leukocyte-specific integrins, molecules that allow cells to enter the inflamed colon to perpetuate disease. Despite the strategy's success, the exact cellular targets remain undetermined. In this study, we consider the functionality of etrolizumab, a drug currently in clinical trials, by using the mouse-specific version of this drug, FIB504, on chronic colitis mouse models. We will use IL-10 mice that adequately function as a model for chronic colitis. FIB504 interacts with integrin beta 7, blocking its role in immune cell adhesion that governs cell migration and homing observed in inflammatory responses. Over eight weeks, we administered FIB504 twice a week in 100 microgram injections. Immune cell behavior and population analysis were done via spectral flow cytometry and serum and stool via ELISA's. We observed B, T, plasma, and dendritic cells via flow and IgA levels via ELISA. We documented the drug's real-time effects on the immune response as FIB504 inhibits specific immune cells from reaching the intestinal tract and hypothesize we will inversely observe accumulating immune cells in the blood. Understanding etrolizumab's functions will revolutionize future treatment for IBD.

Soft Wearable Robots for Assist Upper-Extremity Motions for Infants.

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Action recognition is an important component to improve automation of novel technologies aimed at physical rehabilitation applications. Most existing human action recognition works focus on adult rehabilitation, however, approaches targeted at infants remain underdeveloped. Proposed in this work, BabyNet is a light-weight neural network structure aimed at recognizing reaching motions of infants from off-body stationary cameras. Further, we introduce an annotated dataset that includes reaches performed in sitting posture by different infants in unconstrained environments (e.g., in home settings). Our approach uses the spatial and temporal connection of annotated bounding boxes to interpret onset and offset of reaching, and to detect a complete reaching motion. We test different against other 2D and 3D neural network structures, and compare their performance in terms of capability of capturing temporal inter-dependencies and accuracy of detection of reaching onset and offset. Results indicate our BabyNet can attain a performance comparable to state-of-the-art competing 2D and 3D neural networks.

Foraging of Northern elephant seals: Revelations from a dental diary

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Northern elephant seals (Mirounga angustirostris, NES) are one of the dominant species of pinnipeds of the North Pacific, with colonies on the coast of California and Mexico, but a foraging range that extends far offshore and north to Alaska. Currently, differences in the foraging ecology of NES from Mexican and Californian colonies are not well understood. We used stable isotope analysis of carbon and nitrogen on the annual dentine layers to (1) investigate differences in foraging strategies among Mexican and Californian colonies, and (2) to examine and compare the foraging strategies of female and male NES along their latitudinal range. We found that in most females, the first annual growth layer had higher $\delta^{15}N$ and lower $\delta^{13}C$ values than the average of the rest of the life stages, most likely due to nursing. The $\delta^{13}C$ values differed among rockeries, where the isotopic niche for individuals from Mexican colonies were higher compared to the Californian colonies. The $\delta^{15}N$ values showed little variation between the sexes, while $\delta^{13}C$ values were higher in males because of consistent differences in foraging location. Overall, our results suggest that NES from Mexican colonies do not exploit resources from the coast of Alaska and the Aleutian islands as their Californian counterparts do. Instead, NES from Mexican colonies forage at lower latitudes. Furthermore, results indicate that males forage closer to the shore than females, supporting past results. Therefore, this study more clearly illuminated differences in foraging strategies of NES along their geographic range.

Parental care and the risk of maternally-vectored pathogens: Ammophila transmit Strepsipteran parasites to their young

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Extended parental care is important for protection against natural enemies but can also create opportunities for parents to vector parasites to their offspring via vertical transmission. Such opportunities are occurring in the case of Ammophila wasps. They have varied offspring provisioning behaviors (i.e. differing numbers of prey brought to the offspring), which have developed in response to evolutionary pressure from non-vertically-transmitted parasites. The more developed behaviors meant to reduce parasitism may actually increase attacks on Ammophila offspring by Strepsiptera, which are endoparasitic insects transmitted through offspring-mother contact. Strepsiptera are unique in how they leave permanent signs of parasitism, visible even in preserved host specimens. We have examined thousands of Ammophila specimens from the Bohart Museum of Entomology for these signs of parasitism, thereby converting the specimens into an extensive dataset with which to investigate this host-parasite relationship. Preliminary analyses show that species with more prey items provided—and therefore more extended parental care—have a greater percentage of stylopized individuals. We are continuing analysis by constructing a generalized additive model (GAM) in R to conduct more rigorous tests.

A Wearable Sleeve for Reaching Guidance using Skin Stretch

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The efficacy of movement training methods which incorporate haptic guidance can be improved by providing users with tactile stimuli to the skin. In addition, the emergence of soft actuation and sensing technology has enabled the design of wearable devices that are compliant and lightweight rather than rigid and heavy. This research presents a novel soft, wearable sleeve for haptic guidance and navigation, which leverages skin stretch in the distal (away from the body) and proximal (toward the body) directions. The sleeve consists of neoprene foam bracelets at the wrist and forearm, Velcro straps for fastening the bracelets, and fluidic fabric muscle sheet (FFMS) actuators for stretching the skin on the forearm. Using an adhesive, a rubber material is attached to the skin midway between the bracelets at the ulnar, ventral, radial, and dorsal locations. At each location around the forearm, the rubber is connected in series to two FFMS actuators in an actuator-rubber-actuator configuration, which serves to ground the muscle sheets to the skin. Further, the ends of the actuator-rubber-actuator configuration are anchored to the neoprene bracelets. This allows the individual muscle sheets to be pressurized or depressurized individually, in varying configurations, which in turn displaces the rubber that is attached to the skin in a commanded direction. By stretching the skin at each location under varying configurations, users can be guided to perform forward, backward, upward, downward, leftward, and rightward reaching motions. Ultimately, such a device can provide benefits during skills training in sports, can be used in neurorehabilitation, or can produce realistic haptic sensations on the forearm during virtual reality interactions.

An Acoustic-Electrical Shear Opening Poration (AESOP) platform for high efficient intracellular delivery

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Gene and cell-based therapies have emerged to become promising techniques to treat a wide range of diseases. A key step in gene transfection is efficient and safe delivery of exogenous cargos (e.g. DNA, RNA, and proteins) into the target cells. The most common method in gene transfection is the use of viruses to deliver DNA into the target cells. However, in addition to concerns over provoking inflammatory responses, most viral vectors have limited packaging capacities. As for non-viral methods, lipid-mediated transfection and electroporation are among common delivery strategies. Nevertheless, lipofection method is inefficient for certain cell types (e.g. suspension cell lines and immune cells) and conventional electroporation methods often result in low cell viability when delivering large cargos. Furthermore, both methods face challenges to deliver exogenous materials uniformly into targeted cells. Here, we present a microfluidic platform, AESOP, that integrates LCAT technology and electrode for efficient and controllable delivery of materials into the cells. We hypothesize 4 underlying principles of our AESOP platform: (1) cells trapped in acoustic streaming vortices experience modest mechanical shear that initiates small pores on cell membranes, (2) the applied electrical field does not generate new pores but instead enlarges the pores, (3) the rapid tumbling of cells in the streaming orbits expose the cells to uniform average shear and uniform electrical field strength, (4) and vortices induce chaotic mixing, enabling the uniform delivery of exogenous materials into the cells.

Evaluating Temporal Disaggregation of Streamflow Times Series in Rio Grande Bravo Basin

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Data is not always in the form that is needed, data cannot be available in time or space. The fractal-multifractal (F-FM) method is a deterministic method used to estimate the geometry of seasonally variable and complex time series data, such as streamflow. In this study, the F-MF methods is used to disaggregate monthly to daily natural streamflow data in the Rio Conchos basin. Six control points (gauges) are analyzed: Florido, Conchos, San Pedro, Burras, Granero, and Ojinaga. A total of twenty-seven years of natural streamflow data were estimated for Florido, Conchos, San Pedro, Burras, and Granero, and fifty-one years for Ojinaga. For each control point and year, 300 realizations were calculated using the F-MF method. A set of performance criteria was defined for base flows and peak flows to evaluate the performance of each realization. The F-MF method have a range of different performance for each control point and year. Determining flow patterns in Rio Grande Bravo using the F-FM is important because it provides a sense of what types of daily flows could have happened in the associated control points. It allows us to make some crucial decisions about water availability and its usage.

Surface Characterization Techniques and the study of Solid Electrolyte Interphase and Electrochemical Reactions in Lithium Ion Batteries

SEBASTIEN BANALES, Dr. Ruoxue Yan
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For societies and governmental push from combustion to electric vehicles(EV), the demand for more research within electrochemical reactions in lithium batteries for improved battery systems is imminent in order for EV's to be competitive against combustible engines. To accurately analyze electrochemical reactions on electrodes of lithium batteries and study the phenomena known as Solid Electrolyte Interphase (SEI), I have investigated the surface analysis techniques. Including the working mechanism of Surface-Enhanced Raman Spectroscopy(SERS) in the summer and concluded that in-situ SERS is the best option to study the surface chemistry and detection of surface reactions of electrode materials under working conditions. The SERS substrate (platform) that we use is a close-packed Ag nanocube film, to which I have investigated the synthesis and assembly of the in-situ SERS platform that we will use to enhance the Raman Signals from the electrodes. More specifically, the study of shape control synthesis of silver nanostructures.

Investigation into the interaction between host cells and the coronavirus 3CL protease

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ABSTRACT UNAVAILABLE

Simulation of a Soft Robot Walking Gait with Directionally Adhesive Suction Discs

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Suction discs are able to cling to surfaces by imposing a partial vacuum on the affected surface. While this can create strong adhesion, a system must overcome the suction force keeping the disc adhered when it has to detach from the surface. Because of this, current disc designs are ill-suited for applications requiring frequent detachment, such as walking, despite their potential use in resisting external forces such as underwater currents. In response, we have previously designed a disc that has varying adhesive strength depending on the angle at which a load is applied onto the disc. In modeling the walking motion of a robot, our model was constrained in that the only external control was for limb extension and contraction. While having additional controls for suction force and limb rotation would make a walking gait easier to achieve, this would prove cumbersome to control when later applied to a physical system. In this work, we have simulated the gait of a walking robot with suction discs attached at the end of the robot's limbs, which has allowed us to iteratively determine the parameters required to build a physical system, such as material stiffness, weight, and damping. These parameters were found by determining which values allowed for our robot's legs to shift between angles optimized for suction disc attachment and detachment from the surface. The results of this simulation will not only help to inform the design of a physical robot, but also help to guide future work, such as simulating the motion of a robot with multiple limbs.

Novel Surgical Procedure to Treat Postpartum Hemorrhage

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Postpartum hemorrhage (PPH) occurs in roughly 1-5% of all births and results in 125,000 deaths worldwide. PPH can be caused by uterine atony, which is the excessive enlargement of the uterus due to an inability to contract back into its normal size after childbirth and is more common in cesarean deliveries. PPH usually occurs within 24 hours of delivery but can happen up to 12 weeks after delivery requiring a surgeon to perform uterine compressions to control the bleeding and help the uterus uniformly compress. Unfortunately, due to the complexity of current surgical practices required to treat PPH, this procedure can lead to death if not performed properly in a timely manner. The purpose of our project is to develop a minimally invasive compression suture technique that is quickly and effectively applied by surgeons to treat PPH. We aim to premanufacture a dissolvable compression suture design using poliglecaprone 25 suture that will ensure optimal compression of the uterus, reduce application time, and surgeon error. The preliminary design for our compression suture technique incorporates two longitudinal suture strands that wrap around the uterus and will be secured by slip knots located at each end of the strand. This novel technique will allow the surgeon to easily stitch our prefabricated suture around the uterus and pull down on the knots to compress the uterus. For our initial verification test, we used a neck pillow to model the compressibility and relatively circular shape of the uterus, and we were able to successfully compress the pillow using the novel slip knot design. Furthermore, we were able to validate the dissolvability properties of our design using in vitro methods. In the future, we plan to perform initial safety and performance testing in collaboration with the Department of Gynecology at the University of California, Irvine. If successful, this novel technique will provide surgeons with an effective and safe method to prevent comorbidities associated with PPH.

Measures of Built Neighborhood Environment and Mental Health

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An increasingly relevant framework in understanding both the physical and mental health of a community is considering neighborhood environment. The neighborhood environment consists of many different characteristics such as man-made factors such as buildings/structures, public transport, population density, and neighborhood attributes like walkability, average income, schools, and crime. Neighborhood factors can be protective for an individual; prior studies have shown positive correlations between street connectivity in increased physical activity in an elderly cohort. Furthermore, poor neighborhood environments can also impact an individuals' quality of life, as shown in instances of depression, anxiety, and substance abuse. The study sought to develop different measures of the built environment for the ultimate goal of evaluating how these link to depressive symptoms. A cohort of 375 Mexican American mothers was recruited and studied throughout and beyond pregnancy to collect mental health measures. To assess the neighborhood environment, elements such as land use, street connectivity, walkability, neighborhood opportunity, parks, and school districts were measured through geographic information system (GIS) utilizing data from SANDAG Regional GIS Data Warehouse. A better understanding of the implications of adverse neighborhood environment could have important implications for inequality, human health, and behavior.

Tribological Effects of Varied Operating Conditions

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Information of the tribological behavior of a mechanical system can be extracted by capturing its pressure and film thickness distribution. Effects such as friction and wear can be obtained for design considerations on components such as gears and bearings. However, pressure and film thickness are variables that primarily depend on operating conditions such as flow speed and load. A numerical simulation will be applied using the Python coding program for efficient calculations that will provide an overview of how independent factors will affect tribological properties. The numerical model generally simulates a lubricant flowing between a ball and a flat surface. Ultimately, maximum pressure and minimum film thickness are plotted against conditions including the modulus of elasticity, flow speed, and/or load. This simulation will provide more insight on the effects of the operating conditions in the tribological system which will then be used for future investigation.

Antiviral Gene Expression During HSV-1 Infection of Retinal Organoids

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Herpes simplex virus type 1 (HSV-1) is a virus primarily associated with development of cold sores around the mouth that affects over 3.7 billion individuals worldwide. Little is currently understood about the mechanisms of its lesser-known capability for ocular infection, which in immunocompromised patients often leads to disease and blindness. Retinal infections are a growing cause of concern due to their severity and difficulty to treat, but preliminary unpublished data suggests Muller glial cells show resistance to infection. Due to current rodent models being a poor representation of human retinal infection, we established a human retinal organoid (RO) model for studying HSV-1 infection of the retina. Using this model, we explored immune responses to viral infection in the retina by employing single-cell RNA sequencing. With the data, we identified different retinal cell types, profiled cell type-specific immune responses during HSV-1 infection, and found HSV-1 infection to induce upregulation of genes TNFRSF12A and IRF1. Both genes are implicated to play a role in innate immune response; therefore by monitoring co-expression with other interactome genes, we elucidated potential roles TNFRSF12A and IRF1 could play in retinal organoid cell-type specific antiviral response.

Using Spectroscopic Redshifts to Calibrate Richness for Galaxy Clusters in the Dark Energy Survey

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DES, the Dark Energy Survey, intends to understand the evolution and structure of our universe through statistical analysis of cosmological data. One method we use to create cosmological constraints for dark energy is through measurements of galaxy cluster mass evolution through cosmological time. To calibrate cluster mass, we propose the use of spectroscopic redshift measurements for galaxy clusters in the DES Year 3 redMapPer catalog to formulate a membership probability as a function of redshift and richness. The use of spectroscopic redshift for galaxies allows us to create a distribution of the peculiar velocities for each galaxy relative to their central cluster galaxy and to obtain a precise estimate of cluster membership. In our investigations, the velocity distribution is modeled by a Gaussian Mixture model in order to calibrate projection effects on cluster richness uncertainties. Plotting the projection fraction as a function of richness will help compare real data to cluster simulations in order to determine if redMapPer's cluster richness approximations are accurate or need further investigation. The investigation of projection errors in the redMapPer galaxy cluster catalog using spectroscopic redshift will provide significant contributions to the accurate estimations of mass for DES galaxy clusters and ultimately allow for a deeper understanding of dark energy.

Novel Surgical Procedure to Treat Postpartum Hemorrhage

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Spiroheterocycles and quaternary geminal dialkyl groups are both important molecular motifs in important synthetic and naturally occurring compounds. There are few direct methods available to install a spirocyclic quaternary center adjacent to a second quaternary center. We hypothesized that a geminal dialkyl carbon atom linking the 3-position of a benzo-fused five-membered heteroarene to the β-position of a styrene would lead to a dearomative Friedel–Crafts-type cyclization in the presence of acid, with the heteroarene serving as the electrophile. Herein, we describe a Brønsted acid-catalyzed stereospecific dearomative spirocyclization of benzothiophenes by pendant cis-configured styrenes linked by a geminal dialkyl carbon atom. The reaction optimization is described in detail and is accompanied by a preliminary reaction scope (specifically yield and regioselectivity outcomes due to substituent variation) and mechanistic discussion.

Investigating the Effects of Aging and Diabetes on Pancreatic Alpha Cells

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Data is not always in the form that is needed, data cannot be available in time or space. The fractal-multifractal (F-FM) method is a deterministic method used to estimate the geometry of seasonally variable and complex time series data, such as streamflow. In this study, the F-MF methods is used to disaggregate monthly to daily natural streamflow data in the Rio Conchos basin. Six control points (gauges) are analyzed: Florido, Conchos, San Pedro, Burras, Granero, and Ojinaga. A total of twenty-seven years of natural streamflow data were estimated for Florido, Conchos, San Pedro, Burras, and Granero, and fifty-one years for Ojinaga. For each control point and year, 300 realizations were calculated using the F-MF method. A set of performance criteria was defined for base flows and peak flows to evaluate the performance of each realization. The F-MF method have a range of different performance for each control point and year. Determining flow patterns in Rio Grande Bravo using the F-FM is important because it provides a a sense of what types of daily flows could have happened in the associated control points. It allows us to make some crucial decisions about water availability and its usage.

Kinesin Accumulation

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Kinesin is a motor protein that carry cargo from one end of the microtubule to the other. Mutation in these motor proteins can cause diseases such as Amyotrophic lateral sclerosis, Paraplegia, and Griscelli Syndrome. Kinesins accumulate on one cargo and work as a team to carry that cargo. The experiment started with a fixed amount of Kinesin but due to the complexity of the cell environment, quite a few variables can change the amount. For instance, the fluidity of the cargo membrane, moves multiple kinesin that is tagged to its body which increases the probability that one of those kinesin will attach to microtubule. After one attaches, it increases the chance for others to attach to the microtubule. A Monte Carlos simulation was run to see the effects of kinesin accumulation on the distance the cargo was carried. By understanding the impact of kinesin accumulation, it can be extrapolated to understand the role of lipid membranes.

Low-Cost Home-Made Recording Chambers for Zebra Finch Birds

XAVIER PEREZ, Vikash Gilja, Pablo Tostado
UC San Diego, Engineering/Computer Science, In the Poster Competition

The Songbird Project seeks to develop a neural prosthesis able to decode birdsong from the activity of individual and groups of neurons recorded in different nuclei of the bird's brain. Specifically, we aim to collect simultaneous neural and vocal recordings from freely behaving zebra finch birds, with the purpose of reconstructing a synthetic version of their original song informed by neural activity. The goal of this specific project is to build and develop effective methods for capturing freely occurring birdsong. Here we build a low-cost system of home-made recording chambers using isolated coolers. Creating a comfortable environment for the birds involves the inclusion of a light and a ventilation system. Additionally, we include a USB array of 8 PDM MEMS microphones. This array of microphones will allow us to direct virtual sound beams that will detect the real time position of the source of sound. By applying digital signal processing algorithms to signals recorded from the microphone array we will block or filter out undesired noise and record only the one source of interest: the vocalizations of the bird. The end goal of this project is to build a "clean" library of birdsong data that will expand our ability to understand and characterize song production. With the end goal of clinical translation, our findings will bring us one step closer to understanding the mechanisms of vocal production, and to the development of robust, reliable speech prosthesis for individuals with brain injuries, speech impairments, and/or locked-in syndrome.

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